

Claims

- [1] A plasma treating method in which a pulse voltage is applied between discharge electrodes (4) which are opposingly positioned, to produce a corona discharge between pointed ends of said discharge electrodes (4), and a surface of a workpiece is irradiated with excited species including plasma produced by the corona discharge, thereby treating said surface, wherein

the pulse voltage is alternately applied by pulse voltage applying means (16) configured with using an even voltage doubler rectifier circuit to a central electrode (11) and two peripheral electrodes (12) (13) of said discharge electrodes (4), said discharge electrodes being configured by said central electrode (11) and said two peripheral electrodes (12) (13) opposingly placed in a state where said central electrode (11) is interposed between said peripheral electrodes, and the corona discharge is alternately generated between one of said two peripheral electrodes (12) (13) and said central electrode (11).

- [2] A plasma treating method according to claim 1, wherein a rectangular pulse voltage is used as the pulse voltage.
- [3] A plasma treating method according to claim 1, wherein a pulse voltage configured by plural pulsating waves which are obtained by full-wave rectifying an AC voltage is used as the pulse voltage.

- [4] A plasma treating method according to any one of claims 1 to 3, wherein a magnetic field is formed in vicinities of said pointed ends of said discharge electrodes (4) and in places where charged particles in the plasma exist, and the excited species including plasma are irradiated toward said surface of said workpiece by a pushing force acting on charged particles moving in the magnetic field.
- [5] A plasma treating method according to any one of claims 1 to 4, wherein a reactive gas is introduced between said central electrode (11) and said peripheral electrodes (12) (13) opposing said central electrode (11) at atmospheric pressure or a vicinity of atmospheric pressure, whereby an excitation gas flow including plasma is caused to be irradiated toward said surface of said workpiece.
- [6] A plasma treating apparatus in which a pulse voltage is applied between discharge electrodes (4) which are oppositely positioned, to produce a corona discharge between pointed ends of said discharge electrodes, and a surface of a workpiece is irradiated with excited species including plasma produced by the corona discharge, thereby treating said surface, wherein

said discharge electrodes (4) are configured by a central electrode (11) and two peripheral electrodes (12) (13) placed to oppose said central electrode (11), a center terminal of pulse voltage applying means (16) config-

ured with using an even voltage doubler rectifier circuit is connected to said central electrode (11), side terminals of said pulse voltage applying means (16) are connected to said peripheral electrodes (12) (13), respectively, and, based on an alternating voltage applied to said central electrode (11) and said peripheral electrodes (12) (13), the corona discharge is alternately generated between said central electrode (11) and said peripheral electrodes (12) (13).

- [7] A plasma treating apparatus according to claim 6, wherein said central electrode (11) is formed into a hammer-like shape, and said peripheral electrodes (12) (13) are placed in a state where said peripheral electrodes oppose tip end portions of arms which are extended in opposing directions.
- [8] A plasma treating apparatus according to claim 6 or 7, wherein said pulse voltage applying means (16) is a rectangular-pulse voltage generating power source.
- [9] A plasma treating apparatus according to claim 6 or 7, wherein said pulse voltage applying means (16) is configured by an AC power source, and a rectifier circuit which generates a pulse voltage formed by plural pulsating waves obtained by full-wave rectifying the AC voltage.
- [10] A plasma treating apparatus according to any one of claims 6 to 9, wherein magnetic field forming means (M) is disposed, said magnetic field forming means forming a mag-

netic field in vicinities of said pointed ends of said discharge electrodes (4) which are opposingly placed, and in places where charged particles in the plasma exist, to be able to apply a pushing force to a charged particle moving in the magnetic field, the pushing force causing excited species including plasma to be irradiated toward said surface of said workpiece.

- [11] A plasma treating apparatus according to claim 10, wherein said magnetic field forming means (M) is configured by: a permanent magnet (8); a pair of magnetic members which are connected to N and S poles of said permanent magnet (8), and which elongate to vicinities of said pointed ends of said pair of discharge electrodes (4); and a pair of pole pieces (6) (7) which are continuous to tip ends of said magnetic members, and which form a gap between end faces.
- [12] A plasma treating apparatus according to claim 10, wherein said magnetic field forming means (M) is configured by: an electromagnet connected to a DC power source; a pair of magnetic members which are connected to N and S poles of said electromagnet, and which elongate to vicinities of said pointed ends of said pair of discharge electrodes (4); and a pair of pole pieces (6) (7) which are continuous to tip ends of said magnetic members, and which form a gap between end faces.
- [13] A plasma treating apparatus according to any one of claims

6 to 12, wherein means for introducing a reactive gas between said discharge electrodes at atmospheric pressure or a vicinity of atmospheric pressure is disposed, and the reactive gas is introduced via said means, whereby an excitation gas flow including plasma is caused to be irradiated toward said surface of said workpiece.